Matthew Rodriquez
Secretary for
Environmental Protection

# Department of Toxic Substances Control

Barbara A. Lee, Director
5796 Corporate Avenue
Cypress, California 90630

Edmund G. Brown Jr.
Governor

## MEMORANDUM

**To:** Safouh Sayed
Hazardous Substances Engineer
Cleanup Program, Cypress

**From:** Scott Warren, C.E.G., CHg. ____
Senior Engineering Geologist
Geological Services Unit, Cypress

**Reviewer:** Ted Peng, Ph.D., P.G. ____
Engineering Geologist
Geological Services Unit, Cypress

**Date:** December 17, 2014

**Subject:** draft-partial Groundwater Monitoring and Aquifer Compliance Plan (MACP), Dual Site Groundwater Operable Unit Del Amo Superfund Site, Los Angeles, California (draft-partial MACP), prepared by URS, September 5, 2014. And the
Draft Groundwater Monitoring and Aquifer Compliance Plan, Montrose Superfund Site, 20201 South Normandie Avenue, Los Angeles California, July 23, 2014

PCA: 11018 SITE: 401628-00 REQUEST: 2002

DTSC Cleanup Program Geological Services Unit (GSU) Cypress staff reviewed the Del Amo draft-partial Groundwater Monitoring and Aquifer Compliance Plan (draft-partial MACP) provided by Shell Oil Company on September 5, 2014. The Del Amo draft-partial MACP presents a preliminary sampling/monitoring strategy for monitoring wells Shell Oil Company identified as related to the Del Amo Superfund site benzene plume.

GSU also reviewed the Draft Groundwater Monitoring and Aquifer Compliance Plan, Montrose Superfund Site, 20201 South Normandie Avenue, Los Angeles California, July 23, 2014 provided on November 21, 2014.

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The draft-partial MACP's were reviewed for data gaps and conformance with relevant Department of Toxic Substances Control (DTSC) guidance and industry standards. General comments regarding details of the Report follow. The comments and recommendations in this memorandum are site-specific and should not be construed as policy decision applicable to other sites. Questions regarding this memorandum should be directed to Scott Warren at (714) 484-5462.

The Background section of this memorandum is extensive but provides foundational information necessary to evaluate this partial MACP.

## Compliance Monitoring

Compliance monitoring is required outside of the Technical Impracticability (TI) Waiver - Containment Zone to prove the groundwater cleanup is occurring at an acceptable rate. Robust compliance monitoring of the benzene, chlorobenzene, TCE and pCBSA plumes must continue while the cleanup system and/or remedies are in progress and must continue until the contaminant mass in the TI Waiver Zone degrades sufficiently to present no threat to the environment. The monitoring must be able to prove that contaminant plumes are reducing in size and concentrations in accordance with established plume reduction targets (i. e. 33 percent plume mass reduction in 15 years, 66 percent plume mass reduction in 30 years and 99 percent plume mass reduction in 50 years). If the Respondents fail to meet those target goals, then the plume mass reduction tool employed [groundwater recovery system or intrinsic biodegradation and Dense Non-Aqueous Phase Liquid (DNAPL) and Light Non-Aqueous Phase Liquid (LNAPL) source depletion] must be enhanced and improved until the performance goals are met.

The compliance monitoring must prove that the overall mass is reducing at an acceptable rate. Since the benzene plume remedy is based on intrinsic biodegradation; the benzene monitoring must be able to prove that breakdown products are increasing proportionately to the decreasing benzene concentrations until MCL levels are reached across the entire benzene plume outside of the Containment Zone.

Once the Respondents can prove the contaminant mass outside of the Containment Zone (in each aquifer) for each contaminant of concern (COCs) has reached the MCL throughout the plume area, then monitoring can be reduced to a level that is sufficient to prove the contaminants inside of the Containment Zone are not escaping Containment Zone and impacting the water outside of the Containment Zone.

## Background

### Del Amo

The Former Del Amo facility contained a styrene plant operated by DOW Chemical Co., a butadiene plant operated by Shell Oil Co., and a synthetic rubber facility operated by US Rubber Company. The facilities covered 280 acres and were in operation between the 1940s and 1970s. Wastes from the production processes were spilled, discharged on site or discharged through a pipeline to the Dominguez Channel. The facility was closed in 1972.

Soil contamination was discovered in 1984. Subsequent investigations documented that soil and groundwater in the site vicinity is heavily contaminated with benzene, chlorobenzene, and Trichloroethene (TCE). Additional site background information and operational details can be obtained from previous GSU memoranda (1/10/2012 and/or 8/25/2011) or from: USEPA Overview, Del Amo Facility retrieved 8/15/2011 from: http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/vwsoalphabetic/Del%20Amo%20Facility?OpenDocument .

## Montrose

Montrose Chemical Corporation of California (Montrose) leased a13 acre parcel from Stauffer Chemical Company (Stauffer) in 1947, and manufactured dichlorodiphenyltrichloroethane (DDT) at the property from 1947 to 1982. The 13 acre parcel is located east of Normandie Avenue and north of Del Amo Boulevard in Torrance CA. The Del Amo Superfund Site is located adjacent to and west of the Montrose Chemical Corporation property.

Chlorobenzene (monochlorobenzene) was used in the DDT production process at the Montrose Chemical Corporation site. *(FS Executive Summary, page EX-1)*. ***AECOM and USEPA estimate that approximately two million pounds of Chlorobenzene and DDT were released into the subsurface.*** Parachlorobenzenesulfonic Acid (pCBSA) is a by-product of the DDT manufacturing process. The volume of pCBSA released to the subsurface is not reported.

According to AECOM, "The lateral Extent of DNAPL occurs fully within the TI Waiver Zone established by EPA as part of the groundwater ROD *[(EPA 1999), page EX-2, Lateral Extent of DNAPL, paragraph 1]*. USEPA and AECOM estimates indicate that approximately one million pounds of the Dense (heavier than water) Non-Aqueous Phase Liquid (DNAPL i.e. pure chlorobenzene and pure DDT) waste is entrained in the unsaturated soil (above the groundwater) and approximately one million pounds of DNAPL have entered the groundwater in the saturated zone. These estimates do not account for chlorobenzene that has dissolved into the groundwater.

The toxicity of pCBSA is low, but pCBSA is highly soluble in water. According to the Dual Site Groundwater ROD, up to 1,500 milligrams per Liter (mg/L) was detected in groundwater in the early to mid-1990s in the plume area.

According to the Feasibility Study (FS), dissolved chlorobenzene extends laterally to the southwest for over a mile and has migrated downward over 250 feet into the Gage and

Lynwood drinking water aquifers. Due to the relatively higher water solubility, the pCBSA plume is expected to extend laterally and vertically beyond the chlorobenzene plume. Available data from 1990, 1995 and 2012 supports this observation but monitoring data is very sparse.

## Record of Decision (ROD) for the Dual Site Groundwater Operable Unit

The Dual Site Groundwater Operable Unit ROD (Groundwater ROD) prepared in early 1999 established a "*Dual-site operable unit remedy" (*Declaration, Section 1 Statement of Purpose, page 1, paragraph 3). The Groundwater ROD presents the remedial action for (1) groundwater contamination, and (2) isolation and containment of Non-Aqueous Phase Liquids (NAPL) at the Montrose and Del Amo Superfund Sites.

In the ROD, USEPA and the Responsible Parties (Respondents) agreed to a single groundwater Operable Unit (OU) to capture and treat contaminated water from both plumes as illustrated in the following statement: *"The groundwater contamination at and from the former Montrose and Del Amo plant properties; and the contamination from additional sources that is commingled, or within the area that might be subject to significant hydraulic influences from this remedy; are collectively referred to by EPA as "the Joint Site*". (Declaration, Section 1, Assessment of the Site, page 2, paragraph 2).

According to the Decision Summary (Groundwater ROD, Section II, Decision Summary, Site Names and Location, page 1-1, paragraph 2, "*groundwater contamination associated with these two sites has come to be located over an area extending more than 1.3 miles in length"* (see Figure 2). And *"(1) the groundwater contamination from the two sites was commingled, and (2) the evaluation of remedial alternatives related to groundwater contamination at one site was inseparable"* (Groundwater ROD, Decision Summary, Section 2.5 Enforcement History Related to the Joint Groundwater Remedial Effort, page 2-6, paragraph 2.

There are other potential sources of benzene and chlorinated solvents in the area; these include petroleum transmission pipelines, Stauffer Chemical (benzene), Montrose (benzene), Jones Chemical (PCE, TCE, DCE and benzene) and Solvent Handling Facilities however, Montrose is the only known source of chlorobenzene, DDT and pCBSA (Groundwater ROD, Decision Summary, Section 2.6 Contaminant Sources Other Than the Montrose Chemical and Del Amo Plants, page 2-7 Paragraph 1 and page 2-8, Bullet 3).

Presumably the petroleum transmission pipelines mentioned above could have provided benzene to the facilities, however the Groundwater ROD indicates the petroleum transmission pipelines were and still may be used to transfer petroleum products from the Port to refineries in the area (Decision Summary, Section 2.6 Contaminant Sources Other Than the Montrose Chemical and Del Amo Plants, page 2-8 Bullet 1), implying the pipelines primarily transport unrefined oil. The Groundwater ROD states "*petroleum NAPL containing benzene has been directly observed along this feeder line near historical groundwater monitoring well P-1*. (Decision Summary, Section 2.6 Contaminant Sources Other Than the Montrose Chemical and Del Amo Plants, page 2-

8, bullet 1). The percentage of benzene in the *"petroleum NAPL"* is not mentioned in this passage of the Groundwater ROD. However, according to USEPA, the percentage of light (C2-C5) hydrocarbons in at least one crude oil is less than 4 percent by volume (http://www.epa.gov/region6/6en/xp/longhorn_nepa_documents/lppapp6a.pdf) implying one would expect a relatively small percentage of benzene in unrefined product.

The Groundwater ROD identifies two phases of remedy to address the groundwater and NAPL as follows: the "*operable unit remedy represents the first of two phases of remedy selection that will address groundwater and NAPL at these sites. The first establishes a containment zone and address dissolved phase contamination*" by containing "*dissolved phase contaminants in groundwater surrounding the NAPL in a containment zone, thereby isolating the NAPL, principal threat and the contaminated groundwater immediately surrounding it from groundwater outside the containment zone"* and *"outside the containment zone, reduces dissolved phase concentrations of contaminants in groundwater to health based standards"* (Groundwater ROD, Decision Summary, Section 4.5 Two Phases of Remedy Selection to Address Groundwater and NAPL, page 4-5 Paragraph 1 and page 4-6, Bullets 1 and 2).

## Operable Units and Contaminate Source Areas

The MACP is designed to address a portion of Operable Unit 3 "Dual Site Groundwater", which was the first Record of Decision (ROD) for the Site. The primary Operable Units include:

- OU1 Soil and NAPL Signed in 2011
- OU2 Waste Pit Area Signed in 1997
- OU3 Dual Site Groundwater Signed in 1999

Contaminants found at the former Del Amo facility reportedly originate from at least 13 distinct on-site source areas. The releases reportedly stopped when operations ceased in 1972, however, liquid phase contaminants already in the soil continued migrating through the soil and into the groundwater. In DTSC's opinion, it is likely that most of the contamination is already in the groundwater.

## Light Non-Aqueous Phase Liquid (LNAPL)

*"In the 1960's, the local groundwater basin was adjudicated to reduce the amount of water being withdrawn from the basin and, in turn, limit saltwater intrusion into the basin. As less water was withdrawn from production wells, the water table slowly but steadily rose and overtook the LNAPL, smearing it upward*". According to the Groundwater ROD, "*Some LNAPL was trapped underneath the water table by layers and lenses of the low-permeable formations*" (Section 7 Summary of Site Characterization, subsection *LNAPL at the Del Amo Superfund Site*, page 7-4, paragraph 1).

*"LNAPL at the Del Amo Site occurs in several distinct locations, separated by no more than 600-1,000 feet. These LNAPL sources have been slowly dissolving into groundwater, and have therefore resulted in corresponding distributions of dissolved*

*contamination, which has largely merged and overlapped over time"* (Section 7 Summary of Site Characterization, subsection LNAPL at the Del Amo Superfund Site, page 7-4, paragraph 2).

*"An extensive amount of NAPL-related data has been collected at the **MW-20 Area**, which refers to the area around Monitoring Well No. MW-20. This well is located near what was historically a crude benzene storage tank of at least 500,000 gallons capacity, and a number of pipelines which carried benzene at the former Del Amo plant"* (Section 7 Summary of Site Characterization, subsection LNAPL at the Del Amo Superfund Site, page 7-4, paragraph 3).

## Dense Non-Aqueous Phase Liquid (DNAPL)

Dense Non-Aqueous Phase Liquid (DNAPL) in the TI Waiver Zone and plume area consists mainly of monochlorobenzene (chlorobenzene or MCB) was used in the DDT production process at the Montrose Chemical Corporation site. *(FS Executive Summary, page EX-1)*. ***AECOM and USEPA estimate that approximately two million pounds of Chlorobenzene and DDT were released into the subsurface.*** Parachlorobenzenesulfonic Acid (pCBSA), a by-product of the DDT manufacturing process is also a DNAPL. The volume of pCBSA released to the subsurface is not reported.

Approximately one million pounds of the DDT and chlorobenzene waste is entrained in the unsaturated soil (above the groundwater) and approximately one million pounds of DNAPL have entered the groundwater. The estimates do not account for chlorobenzene and/or pCBSA that dissolved into the groundwater.

## Definition of Plume in the Groundwater ROD

According to the Groundwater ROD: *"plume refers to a defined area in the groundwater based on physical and chemical characteristics. Under this approach, a plume in some cases includes only a subset of the distributions of the chemical bearing its name. Hence, for example, in this ROD the term benzene plume does not refer to all the benzene in groundwater at the joint site; and there is benzene in the chlorobenzene plume not considered to be part of the benzene plume."* (Section 7.2 Conventions for Dividing the Contamination into Plumes, page 7-9, paragraph 4).

However, as EPA points out*, "EPA has not defined the plumes for the purpose of allocating responsibility or liability for cleanup, or to designate from which site (Montrose Chemical or Del Amo Site) particular contamination in groundwater originated. For instance, the contributions of benzene may have arrived in either the chlorobenzene plume or the benzene plume from multiple sources."* (Section 7.2 Conventions for Dividing the Contamination into Plumes, page 7-10, paragraph 1).

For the purpose of this ROD, the plumes are defined as:

- *"Chlorobenzene plume refers to the entire distribution of chlorobenzene in groundwater at the Joint Site, and all other contaminants that are comingled with the chlorobenzene."*
- *"Benzene plume refers to the portion of the distribution of benzene in groundwater at the Joint Site that is not comingled with chlorobenzene." "The benzene plume includes ethyl benzene and naphthalene, among other contaminants."*
- *"TCE and TCE Plume. The term TCE, when used in this ROD, unless otherwise noted, represents a series of chlorinated solvents, including TCE, PCE, DCE, TCA, and any isomers of these compounds in groundwater at the Joint Site. The term TCE plume refers to the portions of the distribution of any such contaminants in groundwater at the Joint Site that are not comingled with the chlorobenzene plume."*

  (Section 7.2 Conventions for Dividing the Contamination into Plumes, page 7-10, Bullet 1 and page 7-11 bullets 1 and 2).

Para-Chlorobenzenesulfonic Acid (pCBSA) does not have an established Maximum Contaminant Level (MCL) however, pCBSA is a byproduct of the DDT manufacturing process and may be considerably more mobile than other contaminants, which make it an excellent indicator. According to the Groundwater ROD for Montrose Chemical and Del Amo Superfund sites, a provisional drinking water standard of 25 mg/L for pCBSA was established. The provisional standard is based on one sub-chronic non-cancer study in which the State of California recommended a non-promulgated and provisional No Observed Adverse Effect Level (NOAEL) of 1 mg/kg/day for pCBSA. (Retrieved 11/20/2014 from http://ndep.nv.gov/bmi/docs/080118ndep-response-organic%20acids.pdf ). As a result, the groundwater remediation system design allows for the reinjection of treated water containing up to 25 mg/L of pCBSA into areas that may degrade drinking water quality.

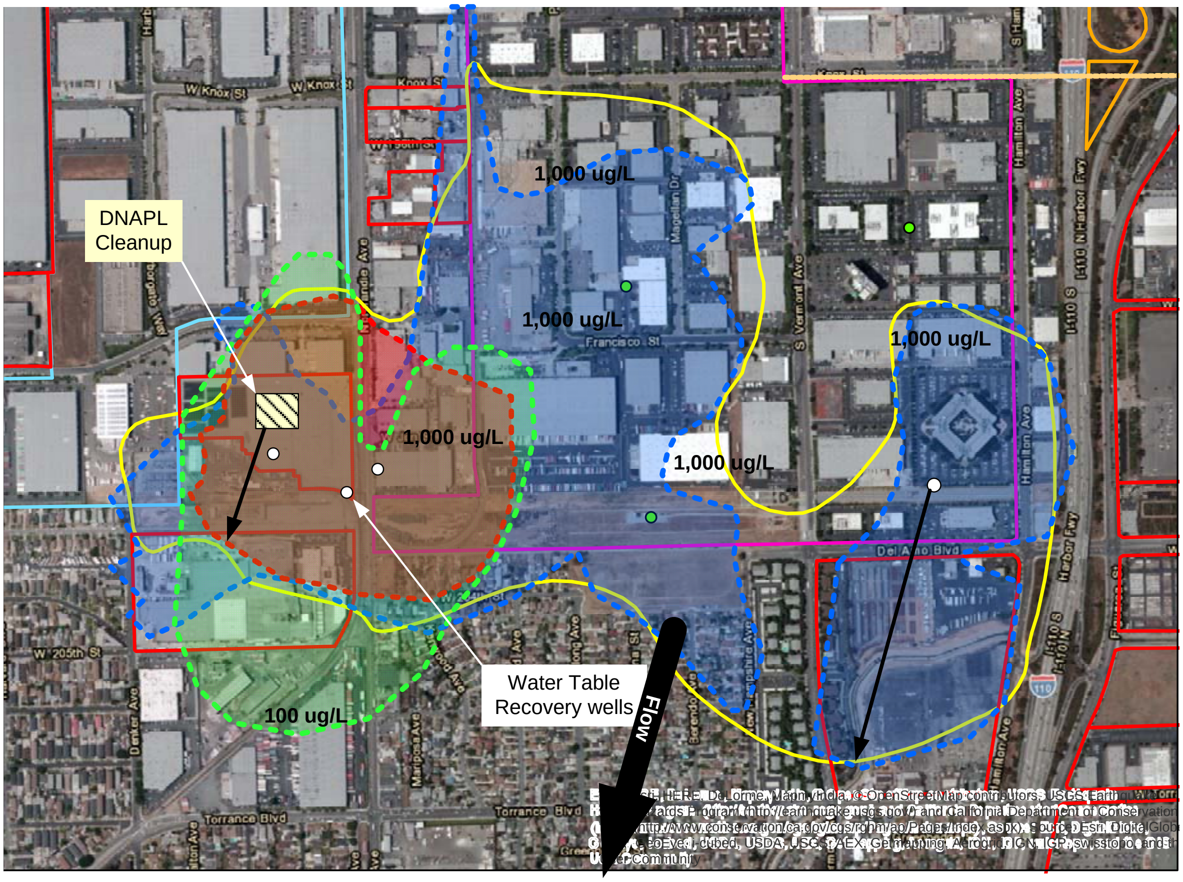
## Areal Extent of Benzene, Monochlorobenzene and pCBSA Plumes

The areal distribution of the benzene, monochlorobenzene and pCBSA plumes in the water table is approximated in Figure 1 below. Figure 1 is based on *Figure 2, Water Table Zone Sampling Locations* prepared by URS and Figures 7 and 8 of the MACP and figures in the Groundwater ROD showing the estimated lateral extent of the chlorobenzene plume in the water table.

**Figure 1 Illustration of Benzene and Chlorobenzene Plumes 2006 and pCBSA in 1990, 1995 and 2012 in the Water Table**

**Montrose and Del Amo Site Area with Water Table TI Waiver (Containment Zone)**

*(benzene plume based on Figure 2, Water Table Zone Sampling Locations, URS), pCBSA plume from ROD Fig. 7-5*




0 0.075 0.15 0.3 Miles

Combined benzene plumes ~ 239 acres im extent. Chlorobenzene plume ~ 61 acres.

**Benzene plume in Blue** **Chlorobenzene plume in Red** **pCBSA plume in Green**

Figure 1 illustrates benzene, chlorobenzene plumes in the water table in 2006 and the partial extent of the pCBSA plume in 1990, 1995 and 2012. The blue area depicts the presumed benzene plume area in the water table zone; the red area represents the approximate lateral extent of chlorobenzene in the water table zone and the green area depicts the presumed lateral extent of the pCBSA plume in the water table zone.

A black line is shown bisecting the benzene and chlorobenzene plumes in the approximate downgradient direction (in the water table). In general, the black line begins in the presumed source area and extends downgradient to plume edge. The line bisecting the benzene plume (blue area) is on the order of 1,750 feet long (in the water table). The line bisecting the chlorobenzene plume (red area) is shown to be approximately 750 feet long. These lines imply that the benzene plume has migrated approximately twice as far as the chlorobenzene plume migrated in the water table which is contrary to statements in the Groundwater ROD.

The TI Waiver (Containment) Zone is illustrated by a yellow line in the plume figures.

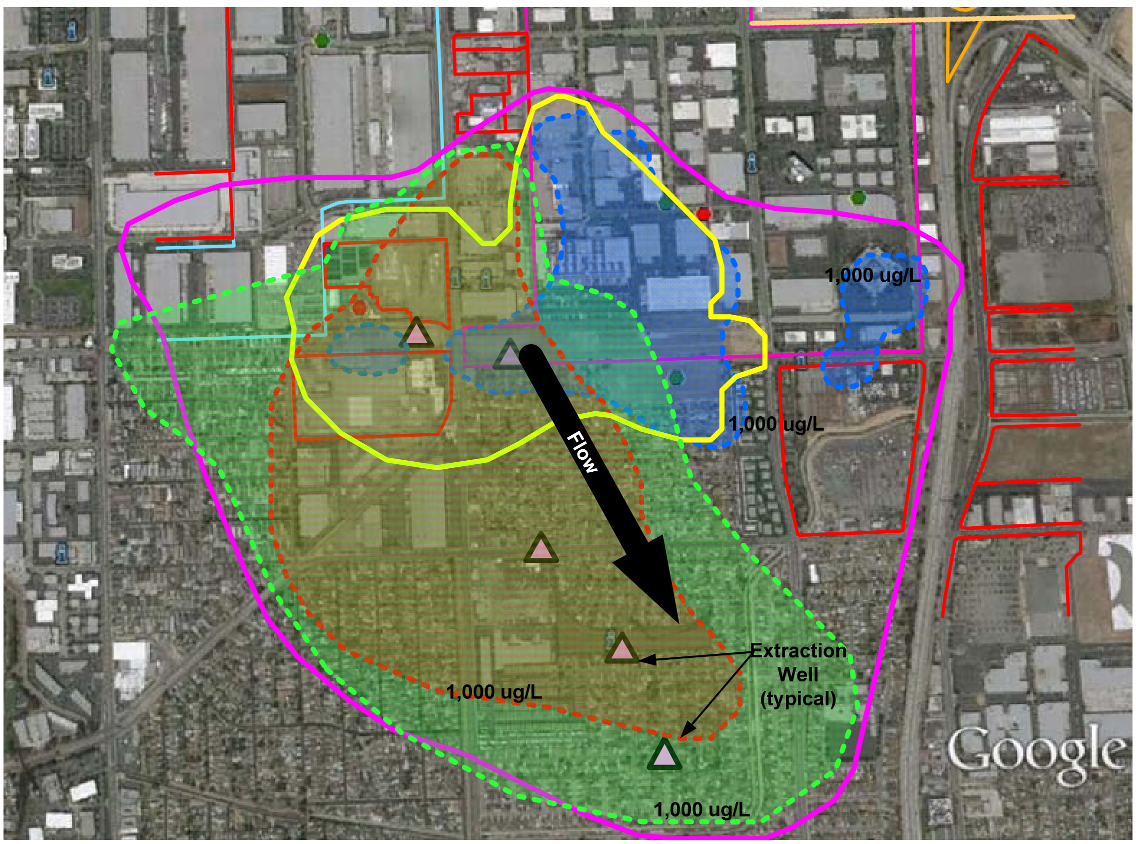
By combining the area of the left and right lobes of the benzene plume in Figure 1 (above), the total area covered by benzene is approximately 239 acres (at the water table surface). The chlorobenzene plume covers approximately 61 acres (at the water table surface).

Both plumes extend further from the site in the MBFB/C Sand (see Figure 2 - below) and in the Gage Aquifer (see Figure 3 - next page). However the monochlorobenzene

**Figure 2 Illustration of Benzene and Chlorobenzene Plumes 2006 and pCBSA (1990, 1995 and 2012) in MBF B/C Sand**

**Montrose and Del Amo Site Area with B/C Sand TI Waiver (Containment Zone)**

*(benzene plume based on Figure 7-3 Groundwater ROD 1999, MCB from CH2MHill 2006 & pCBSA plume from Montrose MACP Figure 10)*




Combined benzene plumes ~ 239 acres im extent. Chlorobenzene plume ~ 61 acres.

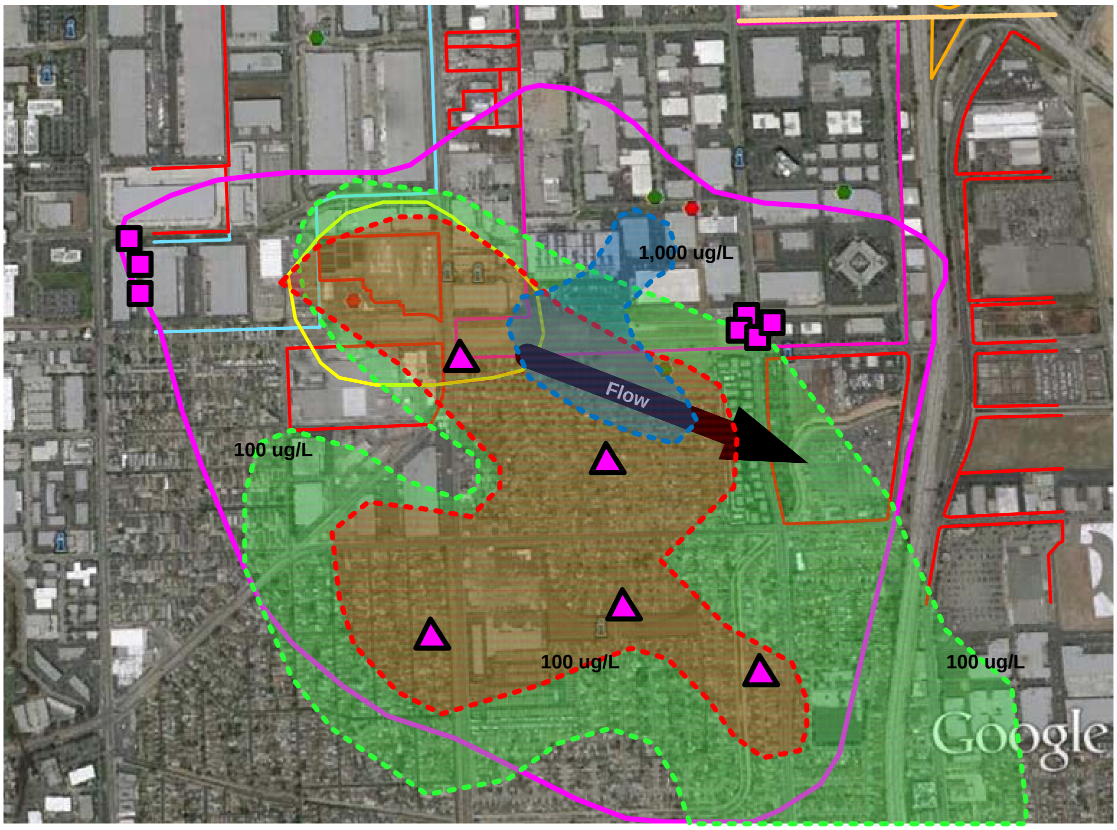
**Benzene plume in Blue Chlorobenzene plume in Red pCBSA plume in Green**

and pCBSA plumes are elongated along a trend from Montrose, along the Kenwood Drain all the down to the ARMCO site. The elongation is clearly shown on Figure 9 (Chlorobenzene in MBFC) and Figure 10 (pCBSA in MBFC, see Montrose MACP).

**Figure 3 Illustration of Benzene and Chlorobenzene Plumes 2006 and pCBSA (1990, 1995 and 2012) in Gage Aquifer**

**Montrose and Del Amo Site Area Gage Aquifer with TI Waiver (Containment Zone)**

*(benzene plume based on Figure 6, Water Table Zone Sampling Locations, URS), chlorobenzene and pCBSA plume from Montrose MACP, data 1990-2012)*




Combined benzene plumes ~ 239 acres im extent. Chlorobenzene plume ~ 61 acres.

**Benzene plume in Blue Chlorobenzene plume in Red pCBSA plume in Green**

The trend remains apparent in the chlorobenzene and pCBSA plumes in the Gage Aquifer [see Figure 3 above and Figure 11 (Chlorobenzene in Gage Aquifer, Montrose MACP) and Figure 12, (pCBSA in Gage Aquifer, Montrose MACP)] even though the direction of groundwater flow is East-Southeast. It appears likely chlorobenzene and pCBSA infiltrated the soil and migrated to the MBF Sands and the underlying Gage aquifer in sufficient quantities to remain elevated decades after site activities ceased.

## Parachlorobenzenesulfonic-acid (pCBSA)

Parachlorobenzene sulfonic acid (pCBSA) is a byproduct of the manufacture of DDT. pCBSA is created when sulfuric acid sulfonates monochlorobenzene (monochlorobenzene is one of the raw materials for making DDT). pCBSA is highly water soluble which reduces its retardation coefficient and has resulted in its moving a greater distance in groundwater than chlorobenzene. (Record of Decision, Decision Summary, Section 12.10 Rationale for EPA's Selected Alternative, Rationale for Remedial Actions for pCBSA, page 12-21, paragraph 1).

*"Because it is much more water-soluble than chlorobenzene, pCBSA is more mobile in groundwater and the lateral extent of the pCBSA in groundwater exceeds that of the chlorobenzene in all directions. The pCBSA plume is commingled with the benzene on the west side of the former Del Amo plant. The maximum concentration of pCBSA is about 1,500,000 ppb, near the Central Process Area. The concentration of pCBSA is 500-1000 ppb at the toe of the chlorobenzene plume (point where chlorobenzene concentrations are at the MCL for chlorobenzene, which is 70 ppb). The pCBSA distribution is shown in Figure 7-5. Because it has no promulgated or provisional health-based standards associated with it, pCBSA is addressed independently of all other chemicals in this ROD."* (Record of Decision, Decision Summary, Section 7.1, Extent and Distribution of Contamination, Generalized Dissolved Contaminant Distributions, page 7-8, paragraph 3).

The requirements specified in the ROD for pCBSA include:

- *"The concentration at which pCBSA is re-injected into the ground shall be limited to 25,000 ppb. The State of California holds that 25,000 µg/l can be considered a provisional health standard for pCBSA with respect to injected groundwater. This requirement is a non-promulgated standard of the State of California (See Section 8 of this ROD), however, it is selected by this ROD as a performance standard for injected groundwater.*

- *The full downgradient extent of pCBSA contamination shall be determined and the movement of pCBSA shall be routinely monitored.*

- *Sampling at potentially susceptible public production wells shall include analyses for pCBSA.*

- *Well surveys shall be routinely updated to identify any new wells which may lie within the pCBSA distribution.*

- *At the Superfund 5-year reviews required by law, EPA will re-evaluate whether additional toxicological studies have been performed for pCBSA, assess the extent of the pCBSA plume and make determinations as to whether the remedy remains protective with respect to pCBSA."*

(Record of Decision, Decision Summary, Section 11.3 Elements Common to All Alternatives, Actions for the Contaminant pCBSA, page 11-27, bullets 1-5).

The 25,000 ppb [micrograms per Liter (µg/L)] limit on aquifer injection of treated water is ***not*** an in-situ standard and does not represent an Insitu Groundwater Standard (ISGS) value. This ROD standard only applies to aquifer injection after groundwater is withdrawn and treated; it does not imply that groundwater in the ground will be cleaned to this value. (Record of Decision, Decision Summary, Section 11.3 Elements Common to All Alternatives, Actions for the Contaminant pCBSA, page 11-27 last paragraph).

At the time the Dual Site Groundwater ROD was written, 95 to 99 percent of the pCBSA could be removed in a treatment train including a Fluidized Bed Reactor (FBR). USEPA indicates in the Dual Site Groundwater ROD that "The additional cost of using FBR, with all other parameters and assumptions constant, was on the order of $5 million" (Record of Decision, Decision Summary, Section 12.10 Rationale for EPA's Selected Alternative, Rationale for Remedial Actions for pCBSA, page 12-22, paragraph 3).

## TI Waiver Zone

It is USEPA policy to return usable groundwater to beneficial use whenever practicable and in a **reasonable timeframe** given the circumstances at the site. However, when restoration of groundwater to beneficial use is not practicable, USEPA's policy is to prevent migration of the plume, prevent exposure to the contaminated groundwater and evaluate further risk reduction. [*Technical Impracticability (TI) Decisions in the Superfund Program, Dave Bartenfelder, 11/2005, EPA Headquarters, Office of Superfund Remediation and Technology Innovation*].

USEPA determined that it would not be possible to clean the groundwater immediately below the source areas to Maximum Contaminant Levels (MCLs) and therefore granted a Technical Impracticability Waiver (TI Waiver) for the water within the TI Waiver i. e. Containment Zone. USEPA agreed to designate lateral limits for LNAPL and DNAPL plumes in the Water Table, MBFB, MBFC Sand and the Gage Aquifer. According to USEPA, for *the "distribution as a whole, however, the concentration gradients are large (i.e. the concentrations taper sharply off with distance from the NAPL source) and the benzene plume appears to be stable. The primary reason for these observations is intrinsic biodegradation of benzene, although it also could be partially attributed to the small hydraulic gradient and groundwater flow velocity of these units."* (Record of Decision, Dual Site Groundwater Operable Unit, Basis for Not Establishing Multiple TI Waiver Zones in These Units, Page 10-8, paragraph 1).

According to the 1999 Groundwater ROD, "*This ROD, in issuing this TI Waiver, determines solely that existing technologies will be incapable of practically recovering enough NAPL (essentially all of it) to attain ISGS levels at all points in the groundwater*." (Record of Decision, Dual Site Groundwater Operable Unit, Section 10.1 Introduction and Provisions, Page 10-2, paragraph 4).

## Biodegradation in the Groundwater ROD

According to the Groundwater ROD, intrinsic biodegradation is "*a remedial mechanism to assist in obtaining remedial objectives at the Joint Site.*" (Section 7.3, Presence of Intrinsic Biodegradation, Page 7-12, paragraph 3). Going further, the Groundwater

ROD points out anecdotal evidence of biodegradation as follows: *"At the Joint Site, there is substantial and significant evidence that significant intrinsic biodegradation of the benzene plume is occurring in the UBF, MBFB Sand and MBFC Sand, these factors include:*

- *Concentration gradients at the leading edge of the benzene plume are steep;*
- *The lateral extent of the dissolved plume outside of the NAPL source is small;*
- *The benzene plume is much smaller than what would be expected based on groundwater velocity and expected retardation in the absence of intrinsic biodegradation; benzene has not migrated far from the NAPL sources despite likely being in the ground 20-40 years;*
- *The plume appears to be at stable and does not appear to be migrating laterally;" and*
- *"Computer modeling runs could not be reasonably calibrated without assuming significant benzene biodegradation."*

The bullets above are a partial list of Bullets in (Section 7.3, Presence of Intrinsic Biodegradation, subsection Potential for Intrinsic Biodegradation in the Benzene Plume, Page 7-12, last paragraph, bullets 1 and 2 and Page 7-13, bullets 1, 2 and 5).

According to the draft-partial Groundwater Monitoring and Aquifer Complaisance Plan (URS, September 5, 2014, page 13, Bullets 1 through 7), monitoring for intrinsic biodegradation will consist entirely of chemical monitoring including analyzing samples from a total of 19 wells for carbon dioxide, methane, nitrate, sulfate, dissolved oxygen, manganese, ferrous iron and total alkalinity. The test locations include 11 locations in the Water Table interval, five in the MBFB Sand interval and three in the MBFC Sand interval [see Table 1, Groundwater Monitoring and Aquifer Complaisance Plan (URS, September 5, 2014)].

## Subsurface Geology

According to the Hydrostratigraphic Block Diagram provided by URS in the Del Amo MACP, (Figure 2) the subsurface geology consists of 6 principal units with two subunits present in the far western portion of the Dual Site Groundwater Operable Unit. The following table illustrates the sequence of the units, the maximum and minimum thickness shown on Figure 2 and the approximate depth to the unit on the southwestern and northwestern side.

| Depth to (feet) | Southwestern Side | Min Thickness (feet) | Max Thickness (feet) | Northeastern Side | Depth to (feet) |
|---|---|---|---|---|---|
| ~0 | Upper Bellflower Aquitard | ~50 | ~70 | Upper Bellflower Aquitard | ~0 |
| ~40 | Middle Bellflower "B" Sand | ~20 | ~30 | Middle Bellflower "B" Sand | ~65 |
| ~60 | Middle Bellflower Mud | ~0 | ~20 | | |
| ~80 | Middle Bellflower "C" Sand | ~70 | ~35 | Middle Bellflower "C" Sand | ~100 |
| ~150 | Lower Bellflower Aquitard | ~25 | ~60 | Lower Bellflower Aquitard | ~130 |
| ~175 | Gage Aquifer | ~50 | ~80 | Gage Aquifer | ~190 |
| ~255 | Gage-Lynwood Aquitard | ~5 | ~60 | Gage-Lynwood Aquitard | ~260 |
| ~280 | Lynwood Aquifer | ? | ? | Lynwood Aquifer | ~300 |

The beds dip gently towards the east. Bed thickness varies and at one point, it appears as if the Gage-Lynwood Aquitard thins to less than five feet in thickness. Head differences between the zones are minimal implying communication across the "aquitards".

## Groundwater

According to the ROD, *"The lateral hydraulic gradient of the groundwater varies locally in the upper units, but is largely consistent in the MBFC Sand and all hydrostratigraphic units beneath it. The direction of groundwater flow in the UBF has local permutations but is generally to the south. The groundwater flow direction in the MBFB Sand, MBFC Sand, Gage Aquifer and Lynwood Aquifer, is to the south to south/southeast". "Under natural gradients (i.e. in the absence of local pumping) the vertical component of the hydraulic gradient is generally downward between all hydrostratigraphic units discussed above".* (Section 7 Summary of Site Characterization, subsection Hydrostratigraphic Units and Groundwater Flow, page 7-6, paragraph 3). The downward gradient appears to influence the downward migration of contaminants, including dissolved phase benzene.

Shallow groundwater is first encountered at a depth of approximately 28 to 49 feet Below Ground Surface (BGS) in the region and has in general risen on the order of 10 feet since 1994 (Approximately 0.5 feet per year on average since 1994). Groundwater flow is generally southeasterly in the shallow aquifers but recent groundwater flow in the water table is towards the southwest. Shallow groundwater in the site vicinity is heavily contaminated with benzene, chlorobenzene, pCBSA and TCE, the groundwater is designated for beneficial use and deeper aquifers are considered to be drinking water aquifers.

Groundwater contamination at the dual site is delineated by a network of over 250 monitoring wells spanning approximately 800 acres. The wells were originally screened in the water table, Middle Bellflower "B" Sand, Middle Bellflower "C" Sand, Gage (Drinking Water) Aquifer, Lynwood (Drinking Water) Aquifer and the Silverado (Drinking Water) Aquifer.

## Draft Partial Del Amo MACP

According to the contractor (Shell Oil Company), "The monitoring program is being conducted to generate groundwater elevation and laboratory analytical data by which to evaluate the extent of the contaminant plume associated with the former synthetic rubber plant and confirm that biodegradation and containment of the plume is occurring." (Page 6, Section 1.4 Monitoring Objectives, paragraph 1).

The benzene has already migrated outside of the TI Waiver zone., Therefore the draft-partial MACPs provided by Shell Oil Company and Montrose need to be designed to demonstrate the Dual Site Groundwater recovery and treatment system can and will restrict chlorobenzene, pCBSA and benzene inside of the "Technical Impracticability Waiver/Containment Zone" and will facilitate cleanup of the dissolved phase plumes outside of the TI Waiver "Containment" Zone.

The MACP (when combined) must also be designed to assure the Dual Site Groundwater Operable Unit is retaining and cleaning up all of the mingled plumes within the plume area as well as containing the contaminants within the TI Waiver Zone. In order to fully monitor the Dual Site Groundwater Operable Unit, the plan must be comprehensive and account for establishing baseline conditions and demonstrating subsequent changes occurring in each of the contaminant plumes (chlorobenzene, pCBSA, benzene and TCE) within or impacting the entire Dual Site Groundwater Operable Unit.

Additionally, the MACP should collect sufficient data to prove intrinsic biodegradation is occurring, where it is occurring, biodegradation rate, breakdown products and where biodegradation is not occurring.

Separate MACP plans (one for Del Amo, another for Montrose and potentially others for other Responsible Parties) designed to monitor parts of the plumes that are within the area of operation of the Dual Site Groundwater Operable Unit are inadequate and cannot be adequately evaluated separately.

## Basic Concepts

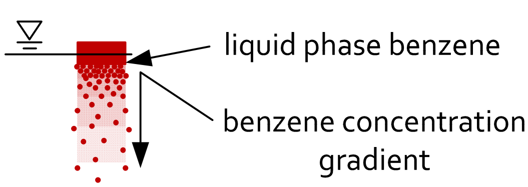
The MACP is required to provide USEPA and the State with a comprehensive tool designed to ensure the groundwater conditions, benzene, chlorobenzene, pCBSA and TCE plumes in the Del-Amo/Montrose vicinity are monitored and tracked, and cleaned up. They should provide sufficient data to document contaminant movement and/or change over time. As discussed above, the contaminant plumes include LNAPL, dissolved phase benzene, DNAPL, dissolved monochlorobenzene, pCBSA, TCE and other constituents of concern.

Dense Non-Aqueous Phase Liquids {in this case Chlorobenzene, pCBSA and TCE (if present)] are denser than water and will tend to sink in water. Soil matrix will impact DNAPL and dissolved phase contaminant migration. Even when dissolved elevated concentrations of chlorobenzene, pCBSA and TCE in water may have a tendency to sink (especially when there is a downward gradient), and diffuse into the water in accordance with their individual water solubility's and dispersion coefficients.

Light Non-Aqueous Phase Liquids (LNAPLs) are less dense than water and will tend to float on the water. LNAPL will tend to be found on the capillary fringe and dissolved into the upper portions of the water bearing interval, however the general downward gradient noted at the site appears to be driving dissolved phase benzene to depth. Benzene will dissolve into the water diffuse into the water in accordance with its water solubility's and dispersion coefficient.

Dissolved benzene will diffuse into the water forming a concentration gradient similar to the conceptual depiction illustrated in Figure 4 below. As is illustrated in Figure 4, benzene is lighter than water and free phase benzene will tend to float on the water (or on the capillary fringe). The benzene will diffuse into the water. Under static conditions, benzene concentrations would be expected to be higher near the water surface, decreasing with distance from the source.

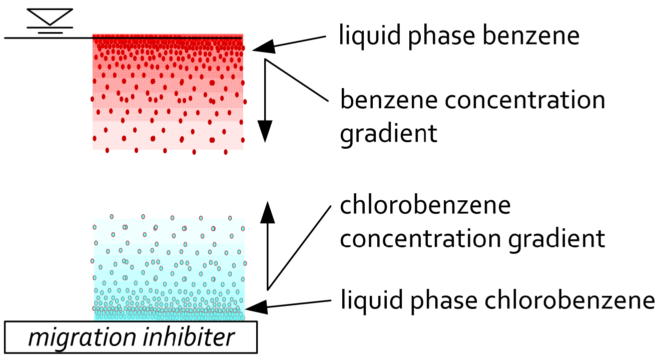
**Figure 4 Diffusion Illustration**




*Benzene concentrations decrease with distance from the source; primarily via chemical diffusion but also partially by mechanical dispersion.*

In the area where the benzene and chlorobenzene plumes are mixed, the lighter contaminants (benzene) would be expected to be most concentrated near the water surface (absent other mixing forces) and the chlorobenzene which has a tendency to sink would be expected to be most concentrated just above any lithologic feature that inhibits its ability to move towards the bottom of the aquifer. Figure 5 illustrates the potential for apparently opposing concentration gradients in conditions where LNAPL and DNAPL plumes co-exist, such as may be the case in portions of the Del Amo and Montrose Superfund Sites.

**Figure 5 Concentration Gradient illustration**




*Benzene and chlorobenzene concentrations decrease with distance from the source. But in the case illustrated, the benzene concetrations should be expected to higher near the water table surface, while chlorobenzene concentrations are expected to be higher above any obstacle that may limit downward migration*

As Figures 4 and 5 illustrate, diffusion forms a concentration gradient, in which the concentration decreases with distance from the source material. Mechanical dispersion will influence contaminant dispersal, for example, there is reported to be a downward gradient at the site which could enhance downward vertical migration of chlorobenzene and benzene.

**Figure 6 Distance Dependent Concentration Gradient Illustration**

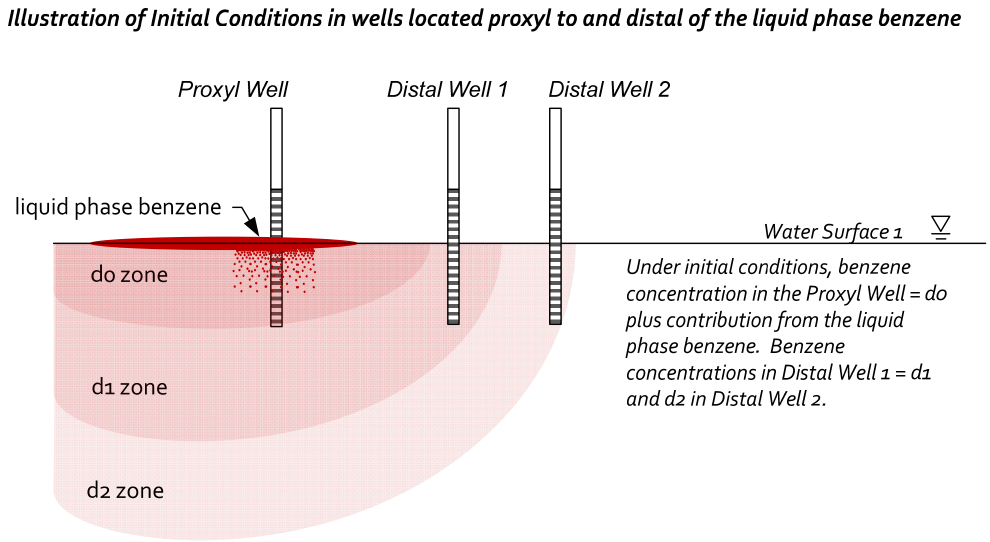



Figure 6 (above) illustrates a series of groundwater wells located in different parts of a benzene plume area and shows how benzene concentrations would be expected to decrease with lateral distance from a continuing source. Figure 6 shows a well design where the monitoring wells are constructed with the screen interval above and below the water surface.

The zones indicated as $d_0$ zone, $d_1$ zone and $d_2$ zone illustrate a concentration gradient where the benzene concentrations decrease as distance from the source material increases. The conditions illustrated here exist within the area of the Dual Site Groundwater Operable Unit.

**Figure 7 Depth Dependent Concentration Gradient Illustration**

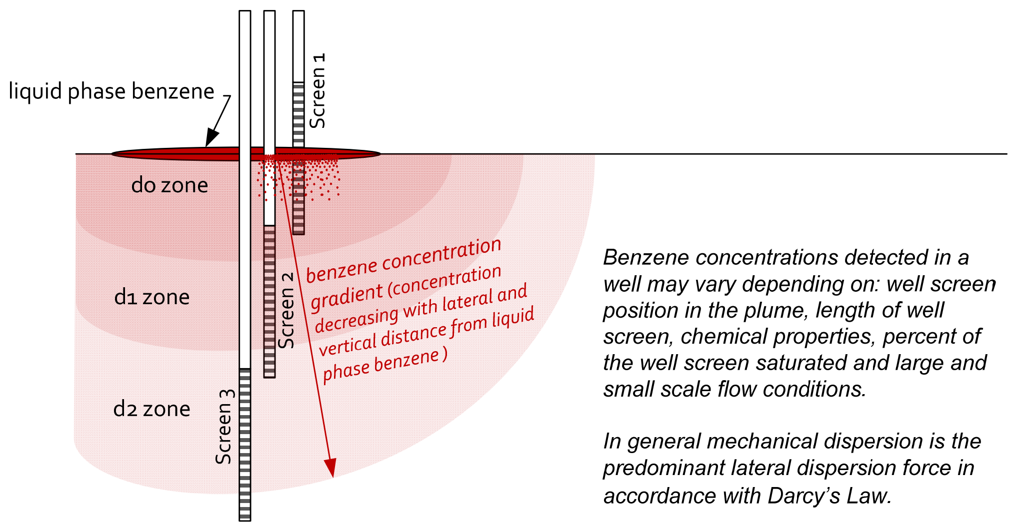



Figure 7 above, illustrates a vertical concentration gradient by showing a series of wells along a vertical profile. Screen 1 is shown as being 50 percent saturated. The submerged portion of the well screen is located within a specific concentration interval ($d_0$ zone). Screen 2 crosses through $d_0$ zone, $d_1$ zone and $d_2$ zone therefore a sample collected from the top of screen 2 could yield a different result that one collected from the bottom of screen 2. A sample collected from the middle could yield an intermediate concentration and complete well purging could yield another result dependent on which zone provides the greatest flow into the well. Screen 3 is also shown transitioning from $D_2$ zone to an unidentified zone, which could also return different results depending on sampling location and methodology. Shorter well screens reduce variation.

The well screens illustrated in Figure 6 are shown as being about 50 percent saturated. Figure 8 illustrates the change in those same wells as the water table rises from Water Surface 1 to Water Surface 2. A contaminant smear zone develops around the wells as the LNAPL and dissolved contaminants rise with the water. Additionally, the volume of water in each well increases which could impact contaminant concentrations in the well. As a result;

1) Changes in the volume of water in the casing could dilute the contaminant concentrations in that well resulting in an apparent contaminant concentration decrease,
2) If the contaminant plume and LNAPL rise above the top of the well screen, the most concentrated part of the plume is physically unable to enter the well, resulting in an apparent decrease in contaminant concentrations,
3) The volume of soil contaminated by benzene increases as the water level rises, meaning contamination spreads vertically, perhaps impeding lateral dispersion.

To illustrate the point, the water level has risen across the entire plume area on the order of ten feet. Using the benzene plume footprint shown in Figure 1, the benzene plume covers on the order of 239 acres. As the groundwater rose ten feet across 239 acres then on the order of 600 to 1,200 acre feet of water heavily contaminated with dissolved phase benzene and LNAPL rose up into and contaminated the former vadose zone across the entire plume area. [Based on an estimated porosity of the soil in the Upper Bellflower Aquitard is on the order of 25 to 50 percent *(Groundwater, R Allan Freeze/John A. Cherry, 1979, page 37, Table 2-4 Range of Values of Porosity)*]. Refer to Figure 1 to see the area where the benzene plume (Blue area) smeared LNAPL and dissolved benzene into the vadose zone. This rise could effectively lower the concentration in an existing well screen due to the "removal" of the most contaminated water and dilution.

In addition to contaminating a very large area, the rising groundwater has impacted the groundwater monitoring well network at the sites. As illustrated before, contaminant concentrations in the monitoring wells are affected by their relative position in the plume both laterally and vertically. Comparing Figure 6 and Figure 8 illustrates the impact a rising water table can have on monitoring wells designed to monitor benzene concentrations in groundwater.

**Figure 8 Interim Conditions Illustration**

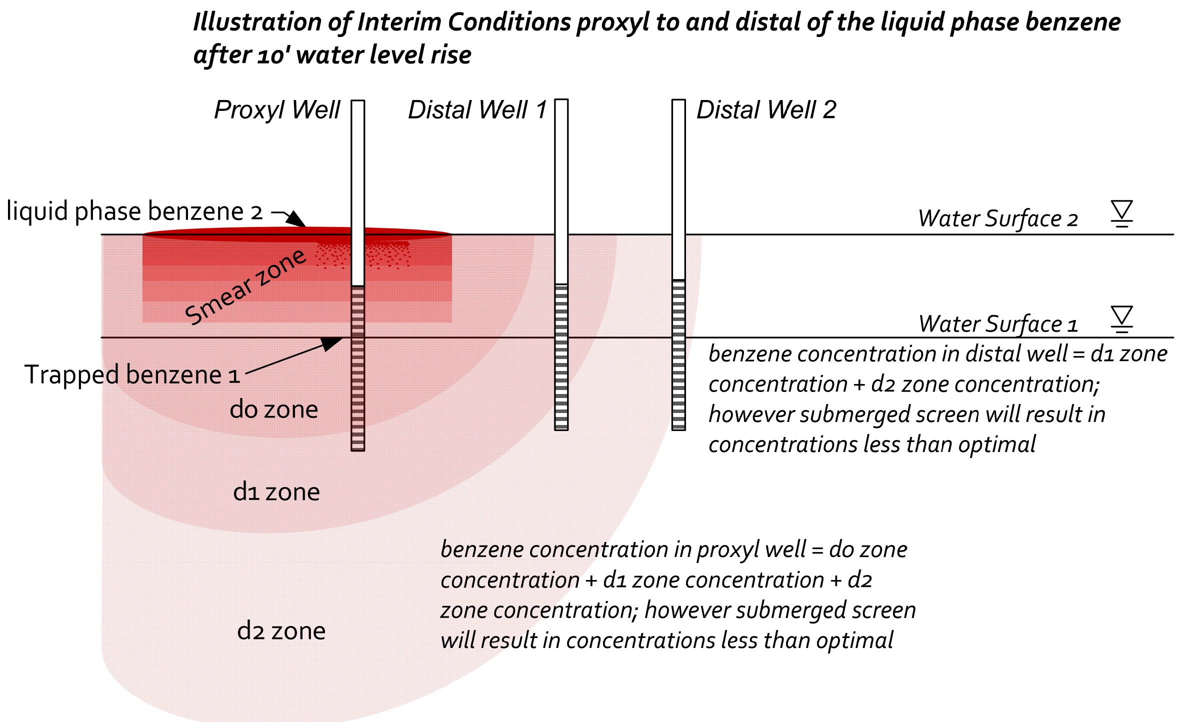



Figure 8 illustrates how LNAPL in the Proximal Well has been cut off and can no longer enter the well. In this case the LNAPL is physically blocked from re-entering the well, which could yield inaccurate plume monitoring information. Comparing monitoring well screen in Figure 6 and Figure 8, it's clear that contaminant concentrations could also appear reduced in distal wells by dilution.

## Fundamental Points

**Fundamental Comment Number 1:** According to the Groundwater ROD:

a. Groundwater contamination from the two sites is comingled,
b. The evaluation of remedial alternatives related to groundwater contamination is inseparable,
c. EPA has not defined the plumes
    i. for the purpose of allocating responsibility or liability for cleanup,
    ii. or to designate from which site (Montrose Chemical or Del Amo Site) particular contamination in groundwater originated.

Based on the statements above, the Dual Site Groundwater Operable Unit is not for Del Amo or Montrose; it is for both and should address all dual site contaminants regardless of origin.

**Fundamental Comment Number 2:** The containment zone identified in the ROD did not take into account that the water level is rising, smearing contamination into uncontaminated areas. The Dual Site Groundwater System is not designed to protect the uncontaminated vadose zone above the 1999 water level. The plume is spreading vertically and impacting hundreds of acres, and bringing volatile contaminants closer to the surface inhabitants, possibly creating a vapor risk. Contaminant mass is also spreading downward into underlying water bearing zones.

**Fundamental Comment Number 3:** The argument made in the ROD (see above) that states “the plume appears stable” and “concentration gradients are steep” does not account for the sequestration of a huge volume of LNAPL and dissolved phase benzene into the formerly unsaturated vadose zone as the water table rises. The sequestration of benzene mass into the formerly unsaturated vadose zone and the continued presence of the benzene, chlorobenzene and pCBSA in the “B” and “C” Sand and the Gage drinking aquifer are strong indicators that the plume is not stable.

**Fundamental Comment Number 4:** The Water Table wells were designed to have approximately 50 percent of the screened interval above the water surface and 50 percent below the water surface. A 10 foot water level rise would result in an increased volume of water in the Water Table wells, which could dilute contaminant concentrations in the samples. Therefore concentration changes in a well over time may not be a reliable indicator of degradation and concentration decreases alone should not be accepted as “proof” of degradation unless accompanied with other lines of evidence.

**Fundamental Comment Number 5:** The Groundwater ROD indicates that intrinsic biodegradation is a remedial mechanism at the joint site. Therefore the contractor must prove intrinsic biodegradation is occurring and must demonstrate the rate of biodegradation and the availability of necessary life supporting material to allow biodegradation to continue. The contractor should ensure they follow USEPA guidance for Monitored Natural Attenuation for Groundwater Cleanups available from http://www.epa.gov/superfund/health/conmedia/gwdocs/monit.htm which should include at least the following lines of evidence:

a. Biological data indicating sufficient populations of the appropriate organisms are present to degrade the plume.
b. The population is supported by sufficient and sufficiently available oxygen and nutrients to allow the biodegradation process to continue.
c. Biological activity is tracked through evidence the populations are active and breaking down the contaminants.
d. Chemical breakdown products and pH are tracked documenting contaminants are breaking down to less toxic degradation products.
e. A mass balance calculation supports the case that biodegradation is occurring and clearly shows where biodegradation is occurring and where it is not occurring.
f. The plume is stable and retreating.

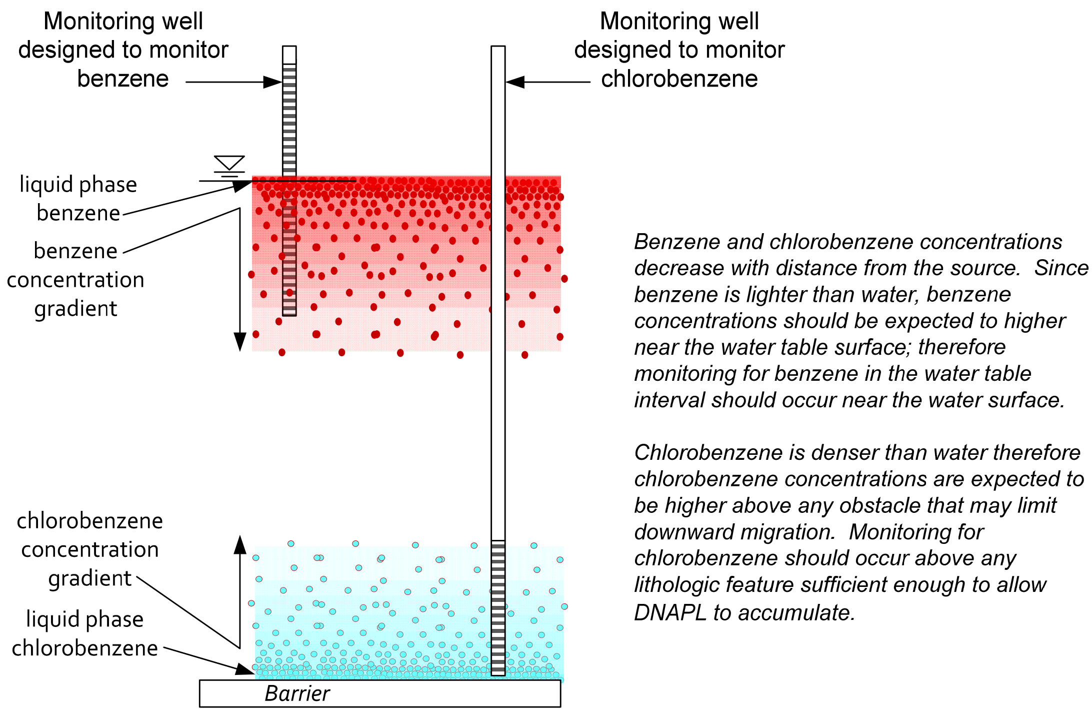
**Fundamental Comment Number 6:** LNAPL and dissolved benzene data from submerged well screens is not comparable to previous readings due to localized changed conditions such as in-well dilution and physically blocking the most contaminated water from entering the well. Therefore:

a. Concentration data from submerged or soon-to-be submerged well screens should not be used for future monitoring.
b. Plume maps based on incongruent data (properly designed/operating well screens and improperly operating submerged well screens) are not comparable and should not be used to monitor plume conditions. Therefore;
    i. Wells used for future LNAPL or benzene monitoring should not have submerged well screens.
    ii. Well screens should be of comparable length.
    iii. Low flow sampling in the same depth interval may yield different results as the water level rises (as illustrated in Figure 7). Therefore results are not directly comparable.

**Fundamental Comment Number 7:** Light and dense contaminants are likely to act differently in the groundwater due to the density and molecular differences of the contaminants. In this case representative concentrations of light contaminants should be expected to be found in the top of the water column, while the denser contaminants are more likely to be detected in the lower part of the water body.

Therefore monitoring for the presence of light contaminants requires wells screened in the water table and shallower parts of the aquifers while monitoring for the presence of denser contaminants requires well screens located above lithologic features that would impede downward contaminant migration. Figure 9 illustrates that wells need to be specifically designed to monitor the different classes of contaminants.

**Figure 9 Conceptual Monitoring Well Illustration**




**Fundamental Comment Number 8:** It has been implied that chlorobenzene at the site has degraded into benzene but scientific evidence to document the degradation of chlorobenzene to benzene has not been provided. Unless this claim can be proven in the field, it should be rejected and the inference discontinued.

**Fundamental Concept Number 9:** DNAPL and LNAPL recovery operations will occur independent of the MACP, but the proposed LNAPL and DNAPL cleanup actions may impact water quality, especially in the water table and B/C Sand intervals. The MACP must be designed to incorporate additional monitoring during and after the LNAPL and DNAPL removal activities to detect, monitor and track the mobilization of contaminants from the vadose zone and/or the saturated zone. The MACP should also clearly describe trigger levels to modify LNAPL and DNAPL cleanup activities and provide a path to disengage the additional sampling when it is no longer needed.

**Fundamental Concept Number 10:** Compliance monitoring must include provisions for monitoring conditions while the groundwater recovery system is in operation; which will likely change in response to changing groundwater plume recovery. The MACP should spell out wells that will be monitored to track operation of the Dual Site Groundwater System and those that will be used to monitor for rebound, once the groundwater recovery system is shut down. The MACP should spell out the goals and timelines for the groundwater recovery system operation and outline the decision logic that will be used for recovery system shut down and/or re-start if containment fails.

**Fundamental Concept Number 11:** Groundwater system performance target goals provided by Montrose are based on a 33% reduction in first 15 years, 66% in the first 30 years and 99% in the first 50 years. This performance target is intended to achieve the cleanup goals within the designated timeframe. However, rebound monitoring will be required.

**Fundamental Concept Number 12:** Continuous compliance monitoring after MCLs are reached in the plume area is necessary to ensure the water quality objective in groundwater is attained and the containment measure is effective.

## General Comments

1. All engineering or geologic work in California should be performed or supervised by a licensed professional in compliance with the requirements of the Professional Engineers Act, Business and Professions Code sections 6700-6799 and the Geologist and Geophysicists Act, Business and Professions Code sections 7800-7887.

   Engineering or geologic work performed as a portion of a Site Investigation should be performed or supervised by a registered Professional Civil Engineer (PE Civil) and/or a Professional Geologist (PG) in compliance with the requirements of the Professional Engineers Act, and the Geologist and Geophysicist Act. The stamp, signature, number and expiration date of the PE (Civil) and/or PG should be on the document indicating the PE or PG oversaw the work and accepts responsibility for the completeness and accuracy of the report.

2. The combined MACP should clearly describe the purpose of the MACP and lay out the compliance requirements. Including:
   a. TI Waiver/Containment zone monitoring requirements and triggers,
   b. Monitoring requirements during and after active LNAPL and DNAPL remediation,
   c. Groundwater treatment system monitoring requirements and triggers,
   d. Plume monitoring requirements for benzene, chlorobenzene, pCBSA and TCE,
   e. Well performance standards and rehabilitation/replacement triggers,
   f. Vapor monitoring triggers,
   g. MNA data and tracking requirements and triggers,
   h. Financial assurance for the duration.

**TI Waiver Zone Compliance Criteria for MCB, pCBSA and Benzene**

As water levels rise in the UBA, Bellflower “B” and Bellflower “C” Sand, concentrations of contaminants will be diluted and concentrations measured in wells will decrease. In order to correct for the added dilution, the Respondents must convert concentration indicator data into contaminant mass so annual comparisons can be made.

In order to demonstrate compliance in the Monitoring and Aquifer Compliance Plan (MACP), the respondents should:

1. Establish a set of Technical Impracticability (TI) Waiver Zone Compliance Wells (i.e. Sentinel Wells) immediately outside of the TI Waiver Zone, especially in the downgradient direction or in the direction of any water pumping that could enhance or influence plume migration.
2. Annually monitor TI Waiver Zone Compliance Wells located immediately outside of the TI Waiver zone for the duration of the plume remediation.
3. Establish a TI Waiver Zone Compliance Zone immediately outside of the TI Waiver Zone. TI Waiver Compliance can only be demonstrated through a series of compliance wells appropriately designed for the contaminants of concern. The Compliance Zone must include the area between the compliance wells and up to a 50 foot wide buffer around the TI Waiver perimeter
4. Measure contaminant concentrations in the TI Waiver Zone Compliance Wells and convert the concentrations into contaminant mass. (to account for dilution and the resulting apparent concentration reduction in the wells.)
5. Demonstrate that the contaminant mass in the TI Waiver Compliance Zone does not increase (based on contaminant concentrations measured in the compliance wells).
6. Monitor compliance of the TI Waiver Compliance Zone for the duration of active plume mass reduction by the Dual Site Groundwater Recovery System.

If the contaminant concentrations measured in the compliance wells indicate that mass in the compliance zone increased, then the Respondents should determine the root cause of the increase and implement a TI Waiver Zone Compliance Action based on their TI Waiver Zone Compliance Contingency Plan to immediately reduce the contaminant concentrations resulting from mass leaking from NAPL source areas into the groundwater compliance zone.

3. **Plume Compliance Criteria during Active MCB, pCBSA and Benzene Removal**

As water levels rise in the Upper Bellflower Aquitard (UBA), Bellflower “B” and Bellflower “C” Sand, concentrations of contaminants will be diluted and concentrations measured in wells will decrease. In order to correct for the added dilution, the

Respondents must convert concentration indicator data measured in the wells into contaminant mass so annual mass comparisons can be made.

Contaminant leakage from the TI Waiver (Containment Zone) or inadequate mass removal by the Dual Site Groundwater Remediation System, intrinsic biodegradation and/or DNAPL/LNAPL removal actions may result in compliance failure. Additionally, compliance monitoring requirements are expected to change over time as mass is removed from the distal parts of the plume and the leading edge of the plume recedes. To accommodate these changes, GSU recommends the plume area (the area outside of the TI Waiver Compliance Zone) be divided into two Compliance Areas in each water bearing zone. The Compliance Areas should be the plume area north of Torrance Boulevard (the Northern Plume Compliance Area) and the plume area south of Torrance Boulevard (the Southern Plume Compliance Area).

## 4. Plume Remediation Compliance Conditions - Northern Plume Compliance Area

The Northern Plume Compliance Area is the area north of Torrance Boulevard and is also the area located closest to the TI Waiver Compliance Zone. Causes of compliance failure in the Northern Plume Compliance Area include leakage from the TI Waiver Containment Zone and/or inadequate mass removal by the Dual Site Groundwater Remediation System.

In order to demonstrate compliance in the Northern Plume Compliance Area, the Respondents should:

1. Establish a designated set of representative compliance wells across the Northern Plume Compliance Area that will be used to demonstrate mass reduction throughout the duration of the plume remediation and the post remediation monitoring period.
2. Ensure the selected indicator wells are appropriately designed and capable of providing consistent contaminant concentration data over time as outlined above.
3. Establish the lateral limits of the Northern Plume Compliance Area and calculate the volume of water in the compliance area.
4. Measure contaminant concentrations in the Compliance Indicator Wells annually.
5. Convert the concentrations measured in the Indicator Wells into contaminant mass by averaging the concentrations and multiplying the result by the plume volume.
6. Demonstrate that the contaminant mass in the Northern Plume Compliance Area decreases by at least two percent per year in accordance with cleanup reduction goals provided by Montrose (Section 2, Groundwater Monitoring Scope and Frequency) in the MACP (33% reduction after 15 years, 66% reduction after 30 years and 99% reduction after 50 years).

7. Monitor compliance of the Northern Plume Compliance Area for the duration of active plume mass reduction by the Dual Site Groundwater Recovery System.

If the contaminant concentrations measured in the Northern Plume Compliance Area Indicator Wells do not demonstrate at least a two percent mass reduction annually in the Northern Plume Compliance Area in each aquifer interval (the combined Water Table, "B" Sand and "C" Sand interval, the Gage Aquifer and the Lynwood Aquifer), then the Respondents must determine the root cause of the deficiency and implement a Northern Plume Compliance Area Action based on the Contingency Plan to immediately reduce the contaminant concentrations in the Compliance Area to an acceptable mass removal rate ($\geq$2 percent per year) .

### 5. Plume Remediation Compliance Conditions - Southern Plume Compliance Area

The Southern Plume Compliance Area is the area south or Torrance Boulevard and is also the area located furthest away and least impacted by the TI Waiver zone. Causes of compliance failure in the Southern Plume Compliance Area could include source leakage from the Kenwood Drain area and/or inadequate mass removal by the Dual Site Groundwater Remediation System.

In order to demonstrate compliance in the Southern Plume Compliance Area, the respondents should:

1. Establish a designated set of representative compliance wells located across the Southern Plume Compliance Area that will be used to demonstrate mass reduction throughout the duration of the plume remediation and the post remediation monitoring period.
2. Ensure the selected indicator wells are appropriately designed and capable of providing consistent contaminant concentration data over time as outlined above.
3. Establish the lateral limits of the Southern Plume Compliance Area and calculate the volume of water in the compliance area.
4. Measure contaminant concentrations in the Compliance Indicator Wells annually.
5. Convert the concentrations measured in the Indicator Wells into contaminant mass by averaging the concentrations and multiplying the result by the plume volume.
6. Demonstrate that the contaminant mass in the Southern Plume Compliance Area decreases by at least two percent per year in accordance with cleanup reduction goals provided by Montrose (Section 2, Groundwater Monitoring Scope and Frequency) in the MACP (33% reduction after 15 years, 66% reduction after 30 years and 99% reduction after 50 years).
7. Monitor compliance of the Southern Plume Compliance Area for the duration of active plume mass reduction by the Dual Site Groundwater Recovery System.

If the contaminant concentrations measured in the Southern Plume Compliance Area Indicator Wells do not demonstrate at least a two percent mass reduction annually in the Southern Plume Compliance Area in each aquifer interval (the combined Water Table, “B” Sand and “C” Sand interval, the Gage Aquifer and the Lynwood Aquifer), then the Respondents must determine the root cause of the deficiency and implement a Southern Plume Compliance Area Action based on the Contingency Plan to immediately reduce the contaminant concentrations in the Compliance Zone to an acceptable mass removal rate ($\geq$2 percent per year) .

**6. TI Waiver Zone Compliance Criteria after Active Remediation Suspension**

Once contaminants in the Northern Plume Compliance Area and the Southern Plume Compliance Area reach Maximum Contaminant Levels (MCLs) in the Northern and Southern Plume Compliance Areas, the Respondents can discontinue active groundwater recovery operations in Northern and Southern Plume Compliance Areas, provided there is no leakage from the TI Waiver zone. In order to assure there is no leakage from the TI Waiver zone, the Respondents should monitor the TI Waiver Zone Compliance wells bi-annually. In order to correct for the expected dilution in the Water Table, “B Sand and “C” Sand, the Respondents must convert concentration indicator data into contaminant mass so bi-annual comparisons can be made.

In order to demonstrate MACP compliance after the remediation system has been placed on standby status (a condition where the groundwater remediation system can be restarted within 30 days), the respondents should:

1. Bi-annually monitor contaminant concentrations in the TI Waiver zone compliance wells (located immediately outside of the TI Waiver zone).
2. Measure contaminant concentrations in the TI compliance wells and convert the concentrations into contaminant mass.
3. Demonstrate that the contaminant mass in the compliance zone around the TI Waiver zone does not increase more than two percent over the 20 year period and the concentrations are below their respective MCLs (based on contaminant concentrations measured in the compliance wells).
4. If compliance is demonstrated during the 20 year period and if contaminant mass does not increase by more than two percent over the twenty year period and the concentrations are below MCLs, the Respondents can demobilize the contingency equipment and prepare the equipment for extended standby.
5. After the 20 years compliance period has been successfully accomplished, monitoring may be reduced to once every five years until MCLs are reached within the TI Waiver zone.

8. **Plume Compliance Criteria after Active Remediation Suspension**

After contaminants in the Northern Plume Compliance Area and the Southern Plume Compliance Area reach Maximum Contaminant Levels (MCLs) in the Northern and Southern Plume Compliance Areas, the Respondents can discontinue active groundwater recovery operations in Northern and Southern Plume Compliance Areas.

The Respondents must demonstrate that contaminant mass in the Northern and Southern Plume Compliance Area Indicator wells does not rebound. In order to demonstrate compliance, the Respondents should monitor the Northern and Southern Plume Compliance Area Indicator Wells bi-annually. In order to correct for the expected dilution in the Water Table, "B Sand and "C" Sand, the Respondents must convert concentration indicator data into contaminant mass so bi-annual comparisons can be made.

In order to demonstrate MACP compliance after the remediation system has been placed on standby status (a condition where the groundwater remediation system can be restarted within 30 days), the respondents should:

1. Re-establish a designated set of representative compliance wells located across the Northern and Southern Plume Compliance Area that will be used to demonstrate that mass does not increase after active remediation is suspended.
2. Ensure the selected indicator wells are appropriately designed and capable of providing consistent contaminant concentration data over time as outlined above.
3. Bi-annually monitor contaminant concentrations in the TI Waiver zone compliance wells (located immediately outside of the TI Waiver zone) and maintain them below MCLs.
4. Measure contaminant concentrations in the Compliance Indicator Wells and convert the concentrations into contaminant mass.
5. Demonstrate that the contaminant mass in the Northern and Southern Plume Compliance Areas does not increase more than two percent over the 20 year period (based on contaminant concentrations measured in the compliance wells).
6. If compliance is demonstrated during the 20 year period and if contaminant mass does not increase by more than two percent over the twenty year period and concentrations are below MCLs, the Respondents can demobilize the contingency equipment and prepare the equipment for extended standby.
7. After the 20 year compliance period has been successfully accomplished, monitoring may be reduced in accordance with intervals designated during the five year reviews.

## Specific Comments – Del Amo (Shell Oil Company) draft partial MACP

### Draft Partial MACP

1. The report is not a stand-alone report. The MACP does not fully describe the purpose of the MACP, it does not provide baseline data such as groundwater monitoring from 1999 to present. It also does not include a description and/or operating parameters for the Dual Site Groundwater Recovery System. In particular the MACP does not describe or provide details regarding which wells are expected to be impacted by the operation of the dual site groundwater recovery system and how these impacts will affect monitoring.
2. Fundamentally, the partial LNAPL and DNAPL MACPs should be merged into one comprehensive MACP.
3. There is no discussion of the purpose and intent of the MACP. The contractor should clearly describe the purpose of the MACP. Why it is needed and what situations it is designed to accommodate. The MACP should clearly describe what it covers and does not cover, it should describe expected impacts of NAPL removal actions, water level rise, multiple lines of evidence for biodegradation and contingencies it is designed to address. The MACP should outline the plume management strategy, including expected monitoring and maintenance for the expected monitoring period and it should spell out compliance points, Data Quality Objectives (DQOs) and actions that will be implemented should compliance not be attained, and/or if intrinsic biodegradation is not effectively meeting the cleanup objectives If financial assurance is required, it should be discussed.
4. The MACP should provide a robust data set that clearly establishes current conditions in and around the groundwater recovery area. The data should include chemical, biological and flow data that will form the basis of all future site decisions. It must include multiple lines of evidence for each chemical and biological parameter necessary to document changes in the plume over time.
5. The contractor provided time-series groundwater monitoring data in the 2012 Groundwater Monitoring Report. The data should be included in the MACP and figures should be updated to show 2012 conditions. Additionally, the contractor should provide a map showing the relative rise in the water table between 1999 and 2012 across the entire Dual Site area. If trends are apparent, the contractor should discuss the trends and ensure the MACP will accommodate predictable future conditions.

### Monitored Intrinsic Biodegradation

6. Page 5, Section 1.1, Background, paragraph 1: *"The benzene plume remedy as outlined in the ROD and subsequent Model Development and Remedial Wellfield Optimization Report (USEPA 2008), consists primarily of monitored intrinsic biodegradation."* While this is outlined in the groundwater ROD, the contractors have not provided proof of biodegradation. The contractor must be able to prove intrinsic biodegradation is occurring, where, how, how fast, limiting factors and where intrinsic biodegradation is not occurring. The contractor should provide

biological and chemical data (including monitoring breakdown products) to prove biodegradation is occurring, the type of biodegradation (aerobic/anaerobic), degradation rates in different parts of the benzene plume inside and outside of the TI Waiver zone and estimates for when cleanup may be complete in the source area and outside of the source area.

7. The contractor shows a series of “Natural Attenuation Transects” but there is no explanation regarding the purpose or benefit of showing these transects. The contractors should explain their relevance or remove them.
8. In the table, the contractor lists the wells that will be monitored for biodegradation parameters. The contractor should show the locations of these wells on a map and ensure they spatially (laterally and vertically) distributed and representative of the concentration ranges in each interval. The wells proposed to demonstrate biodegradation in the MBFB Sand, MFBC Sand and Gage are not spatially and distributed and are not sufficient to demonstrate biodegradation conditions throughout the plume. A broad distribution of wells should be proposed that are suitable to demonstrate biodegradation progress in each interval and in the range of concentrations and conditions at the site.

**LNAPL and Dissolved Phase Contaminant Plumes**

9. The contractor did not discuss the extent of Light Non-Aqueous Phase Liquid (LNAPL). The contractor should discuss the occurrence/distribution of LNAPL at the site, in particular where it is or has been detected in the site vicinity.
10. LNAPL and/or DNAPL removal actions are planned. The contractor should show the locations of the proposed actions and discuss any perceived impact DNAPL and/or LNAPL removal actions may have on plume monitoring in the MACP.
11. Figure 2 of the MACP (Hydrostratigraphic Block Diagram) illustrates the subsurface stratigraphy and the occurrence of first groundwater. The hydrostratigraphic diagram shows the first groundwater occurs in both the Upper bellflower interval and the Middle Bellflower “B” Sand. The Responsible Parties [Respondents (Montrose and Del Amo)] refer to water bearing zones by different names. In order to unify the MACP, the Respondents should adopt the same terminology. Additionally, the contractors should simply the Conceptual Site Model by referring to all wells in the first groundwater as Water Table wells.
12. Page 6 contractor refers to “*The gage Aquifer plume area attributable to the former plant site is limited to the northern plume centered at well SWL0063. Similar to the MBFC, the larger benzene plume area of lesser concentrations further south is coincident with the Montrose chlorobenzene plume and not attributable to a Del Amo source.”* The contractor should provide scientific evidence to support their case that the plumes are different, however USEPA stated in the ROD the plumes regardless of source will be treated together.
13. Some concentration contours shown on the Isoconcentration contour maps do not appear to have related data points. The contractor should resolve the issue accordingly.
14. Benzene extends beyond the TI Waiver zone in the first water interval (the Water Table and the MBFB Sand), in multiple location but there are no monitoring wells

downgradient of the high concentrations. The contractor should provide plans to monitor the plume in all areas where the plume appears to be migrating out of the TI Waiver zone and they should implement corrective action to stop the plume advance and to protect the water outside of the containment zone.

**Dual Site Groundwater Operable Unit**

15. Extraction well locations and areas of influence for the groundwater recovery and treatment system are not shown on the maps. The contractor should show the locations of the groundwater recovery wells in the different aquifers, presumed zones of influence and should discuss the potential impact the groundwater extraction/injection system will exert on the MACP monitoring wells.
16. The Groundwater ROD, states *"Computer modeling runs could not be reasonably calibrated without assuming significant benzene biodegradation."* The contractor should factor in the LNAPL and benzene mass stored in the now saturated unsaturated zone and see if the model mimics reality when factoring in the loss of mass to the vadose zone.

**Contingencies**

17. The contractor should discuss the plume containment strategy and how this plan will provide the data and triggers to ensure compliance. It should propose actions if compliance is not achieved.
18. The Contractor does not discuss which proposed monitoring wells have well screens that are submerged, or may become submerged in the foreseeable future. Submerged well screens are not acceptable for use to compare to non-submerged well screens. The contractor should ensure there are sufficient properly constructed wells to monitor the free phase LNAPL, dissolved phase benzene plume and clean water indicators.
19. As illustrated above, rising water table contributes to apparent decreased concentrations of contaminants. The Contractor should discuss the potential impact of the rising water table especially in regards to contaminant smearing in the vadose zone and apparent contaminant reductions in monitoring wells. The contractor should also discuss when wells will be removed from service due to submerged well screens, well destruction techniques and steps that will be used to design and install replacement wells.
20. The contractor should provide a comprehensive table showing the well Number, X Y and Z coordinates to 1/100 foot, date well completed, date of survey, well diameter, top of screen elevation and depth, screen interval and geologic unit, proposed use in the MACP (gauging only, sampling etc.), presence of free product in well and highlight any wells with submerged well screens.
21. The contractor should discuss the rising water table and discuss any perceived impact the rising water table will have on the Dual Site Groundwater Recovery system. The discussion should address why the water table is rising, is it rising uniformly, from one side or all around the Dual Site Groundwater Recovery System. The discussion should include a section to discuss potential vapor intrusion ramifications of water level rise.

22. The contractor indicates they will sample a few wells near the TI Waiver zone boundary or just outside of the TI Waiver zone. The MACP should have a contingency that if any of the perimeter wells have benzene above the MCL, then additional samples will be collected outboard and downgradient of the detection. It should propose corrective action they will implement to contain the plume.

## Specific Comments – Montrose draft partial MACP

### Draft Partial MACP

1. Fundamentally, the partial LNAPL and DNAPL MACPs should be merged into one comprehensive MACP.
2. The contractor should clearly describe the purpose of the MACP. Why it is needed and what situations it is designed to accommodate. The MACP should clearly describe what it covers and does not cover, it should describe expected impacts of NAPL removal actions, water level rise, multiple lines of evidence for biodegradation and contingencies it is designed to address. The MACP should outline the plume management strategy, including expected monitoring and maintenance for the expected monitoring period and it should spell out compliance points, Data Quality Objectives (DQOs) and actions that will be implemented should compliance not be attained. If financial assurance is required, it should be discussed.
3. The MACP should provide a robust data set that clearly establishes current conditions in and around the groundwater recovery area. The data should include chemical, biological and flow data that will form the basis of all future site decisions. It must include multiple lines of evidence for each chemical and biological parameter necessary to document changes in the plume over time.
4. The contractor provided time-series groundwater monitoring data in the 2012 Groundwater Monitoring Report.
5. The draft partial Montrose MACP should include clear provisions to monitor pCBSA, chlorobenzene, benzene and TCE. If as postulated, chlorobenzene degrades into benzene, then Montrose must demonstrate how and where this transformation is occurring and monitor the benzene plume and any other daughter product plumes as well.
6. If natural degradation is a part of the proposed remedial approach, then biodegradation parameters must also be measured. Additionally, the Respondents should provide a narrative discussing the persistence of pCBSA in the environment, including a discussion of the potential biodegradation of pCBSA and/or any interference its presence may cause for the biodegradation of benzene and/or chlorobenzene.
7. The injection wells are not shown on the figures presented. Injection will move contaminants, therefore it is critical that wells around the injection points be measured to track contaminant movement and to track pCBSA injection into

clean water, which would degrade existing water quality. This is especially important in the Gage and Lynwood drinking water aquifers.

**Dissolved Phase Contaminant Plumes**

8. Figure 2 of the Del Amo MACP (Hydrostratigraphic Block Diagram) illustrates the subsurface stratigraphy and the occurrence of first groundwater. The hydrostratigraphic diagram shows the first groundwater occurs in both the Upper Bellflower interval and the Middle Bellflower “B” Sand. The Respondents (Montrose and Del Amo) refer to water bearing zones by different names. In order to unify the MACP, the Respondents should adopt the same terminology. Additionally, the contractors should simply the Conceptual Site Model by referring to all wells in the first groundwater as Water Table wells.
9. Contaminant plume maps are provided however the data used to construct the plume is not contemporaneous. The plume maps indicate data used is from prior to 2012 of from 2012. In the case of pCBSA the pre-2012 data is from 1990 or 1995. The contractor should clearly indicate the date data is collected by year and plume boundary as well as plume concentration maps should be based on recent contemporaneous (same year) data.
10. According to the Groundwater ROD, the RP is responsible to monitor nearby drinking water wells for pCBSA, however, pCBSA data has not been collected since 1995. The Respondents should monitor for and track the distribution and movement of pCBSA in each aquifer/water bearing zone.
11. Nearby drinking water wells are present and could be impacted by pCBSA. The RP should monitor and track water quality in the Gage and Lynwood aquifer in the nearby drinking water/production wells. Wells not being used regularly are especially likely to act as conduits; therefore the Respondents should ensure the wells are free of pCBSA, monochlorobenzene and benzene. Water Replenishment District well 219-02 (owned and operated by California Water Service Company) is located downgradient of the site. The Respondents should secure permission to monitor this well and any other nearby drinking water well or drinking water aquifer monitoring well that could be impacted or may provide plume and or plume boundary information.
12. Since well 219-02 is a drinking water well, the Respondents should install and monitor a nested well between the estimated extent of the monochlorobenzene plume and well 219-02 to act as a sentinel well. If pCBSA, monochlorobenzene or benzene are detected in the sentinel well in the B/C Sand, Gage or Lynwood aquifer, then protective steps should be required to protect the condition of the drinking water.

**Dual Site Groundwater Operable Unit**

13. Extraction well locations and areas of influence for the groundwater recovery and treatment system are not shown on the maps. The contractor should show the locations of the groundwater recovery wells in the different aquifers, presumed zones of influence and should discuss the potential impact the groundwater extraction/injection system will exert on the MACP monitoring wells.

14. The Dual Site Groundwater ROD clearly states that the operators of the Dual Site Groundwater ROD must monitor the lateral and vertical extent of the pCBSA plume. The Montrose partial MACP does not mention monitoring the plume. Montrose should monitor the pCBSA plume, illustrate the lateral and vertical extent and demonstrate how and when they will comply with each part of the Dual Site Groundwater ROD?
15. The Dual Site Groundwater ROD states that the "*State of California holds that 25,000 μg/l can be considered a provisional health standard for pCBSA with respect to injected groundwater".* In order to ensure compliance with the Basin Plan and Waste Discharge Requirements (WDRs), Los Angeles Regional Water Quality Control Board (LARWQCB) input regarding re-injecting PCBSA is crucial. USEPA should ensure the LARWQCB to verify the reinjection of pCBSA is in compliance with State standards.
16. If the Montrose/Del Amo Dual Site groundwater system is capable of enhancing movement of TCE towards the recovery system, then Montrose (or Montrose/Del Amo) should also monitor TCE concentrations upgradient.
17. The current proposal does not provide adequate data to understand the groundwater gradient and flow, especially to the northwest. Montrose (or Montrose/Del Amo) must measure depth to water across the entire area annually to understand groundwater flow before, during and after operation of the dual site groundwater recovery system.
18. Monitoring one well in the Lynwood aquifer is unacceptable. If there is fear of installing additional monitoring wells in the plume, then wells should be considered around the edges of the plume to track potential degradation of drinking water.

**Contingencies**

19. The contractor should discuss the plume containment strategy and how this plan will provide the data and triggers to ensure compliance. It should propose actions if compliance is not achieved.
20. Monochlorobenzene extends beyond the TI Waiver zone in the first water interval (the Water Table and the MBFB Sand), in multiple location but there are no monitoring wells downgradient of the high concentrations. The contractor should provide plans to monitor the plume in all areas where the plume appears to be migrating out of the TI Waiver zone and they should implement corrective action to stop the plume advance and to protect the water outside of the containment zone.